PALEOALPINE PALEOKARST OF THE WESTERN CARPATHIANS

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Abstract : Paleotectonic and paleoclimatic roots of the longest and most significant karst period in Western Carpathians — the Paleoalpine paleokarst period — are described. Karst phenomena which originated in the Paleoalpine period were created in climatic and tectonic environments that diametrically differ not only from the present–day circumstances but also from the Neoalpine (Miocene–Quaternary) ones. They are an integral part of the contemporary landscape of Western Carpathians..

Key words: Western Carpathians, paleokarst forms, sediments

1. Introduction

It is widely believed that the contemporary landscape of young alpine mountain ranges – including the karst – is very young, often no older than Miocene. This idea has supporters mainly among geomorphologists. They suppose that the denudation chronology, including the karstification, should be started only up to the Neoalpine period, in Upper Miocene. The aim of this work is to present the paleokarst forms and sediments more complex and to explain the paleotectonic and paleoclimatic roots of the Paleoalpine paleokarst period – the longest and most significant karst period in Western Carpathians.

2. Geological background of the Paleoalpine paleokarst

Paleogeographic and paleotectonic syntheses about European Alpides — and within them also about the Western Carpathians — accept important horizontal movements of lithospherical plates or microcontinents (Maheľ 1978, Tollmann 1978, Roth 1980, Michalík & Kováč 1982 and others). The Western Carpathians formed as a result of a collision between the NW margin of the Apulian microcontinent, the Alpine–Carpathian shelf fragment and the European platform margin (Michalík & Kováč 1982, Michalík & Činčura 1992). This collision occured in several phases. From the karsological viewpoint the main phases of the collision were important, since they represented significant periods of continental evolution. To the most important phases of the collision of the

approx. 250 Ma long Alpine stage belong: 1. Paleoalpine stage, which began approx. 100 Ma ago, roughly during the Middle Cretaceous; 2. Neoalpine, Savian–Styrian, or early Lower Miocene stage, which began approx. 20 Ma ago.

For an area to become karstified, the region must possess the following set of features: There must be a considerable thickness (preferably some hundreds of meters) of rock which is to some extent soluble, there should be a moderate to heavy rainfall since solution of the rock cannot take place without adequate water and a „available relief“ or the height of the area above sea level, should preferable be some tens to hundreds of meters.

The tectonic superunits of Hronicum (in the West) and Silicicum (in the East) are the most important building elements of the main karst regions of Western Carpathians. Conspicuous are mainly thick complexes of Middle and Upper Triassic limestones and dolomites, which predeterminated the general karst character of parts of Malé Karpaty Mts, Strážovské vrchy Mts., Malá Fatra Mts, Nízke Tatry Mts, Slovenský raj Mts , Slovak Karst etc.

In both tectonic superunits extensive carbonate platforms came into being along with the sedimentation of Gutenstein limestones and dolomites. The younger Steinalm limestones are composed predominantly of algal stalk fragments and of other organisms. In the Silicicum superunit during the later stages the facial regions became diversified into the facies of carbonate platform – the whole Middle and Upper Triassic is developed in the carbonate platform facies (Wetterstein, Tisovec and Dachstein limestones) and the facies of intraplatform depressions and pelagic facies (Schreyeralm, Nádaska, Reifling and Raming limestones). Paleoalpine karst is most notably developed on mentioned limestones and dolomites in the Central and Inner Western Carpathians.

3. Paleotectonic and paleoclimatic background of the Paleoalpine paleokarst

The development of Paleoalpine relief on the limestones and dolomites of the Hronic and Silicic was controlled by paleotectonic factors. In the Western Carpathian space the Paleoalpine collision led to stabilization, or reconsolidation. Paleoalpine emergence as well as the subsequent subaeric development, were the results of this collision phase during approximatelly the Middle Cretaceous (Michalík & Činčura 1992). The onset of terrestrial development however was not simultaneous in the whole Western Carpathian space. The unequal duration of the Paleoalpine emergence is a result of this. It may generally be stated, that sedimentation ended earlier in the southern units than in those situated further to the north.. The maximal length of terrestrial evolution caused by the Paleoalpine collision known up to now varies in Slovak Western Carpathians about 110 Ma (Činčura & Köhler 1995).

The development of Paleoalpine karst relief on the basement was controlled also by climatic factors. At the beginning of the Paleoalpine emergence the Western Carpathian space lay in the

subequatorial, or tropical zone in the northern part of the Tethys ocean (Činčura 1987, 1988). The extensive northern continent of Fennosarmatia warmed up in hot summers more rapidly than the water of the Tethys due to its higher thermal conductivity. Relatively lower air pressures originated therefore during the summer months over the continent than over the ocean. Humid oceanic air flowed from ocean waters to such barometric minima; the air, due to intensive evaporation caused by high temperatures brought summer clouds and ample precipitation. The summer monsoon provided probably substantial precipitation not only to the southern coast of Fennosarmatia, but also to the slopes of the Middle and Upper Cretaceous relief of the Western Carpathians. In the winter time the pressure conditions changed. A pressure maximum originated over Fennosarmatia; from here dry air masses were flowing over the Western Carpathian space towards the area of pressure minima over the ocean. The climate was characterized by high annual average temperatures and only small temperature variations during the year. Annual rainfall was evidently high, but precipitation was concentrated in the summer monsoon, while the winter monsoon season was dry.

4. Karst development during the Paleoalpine period

The surface of the basement was at the above mentioned climate conditions exposed to intensive karstification and weathering processes. The weathering products were above all red kaolinite and kaolinite–montmorillonite weathering crusts (silts/clays); bauxites or ferricrusts formed at several places as well.

From a morphotectonical viewpoint it is an interesting question, whether a mountain range in the morphological meaning of the word formed on the basement during the Paleoalpine pariod. This would mean a convex unit with mountainous relief, separated from the adjoining lower parts by a marked foothil. Thus formulated question can be at least partly answered on the basis of an analysis of Upper Cretaceous sediments of the basement

The formation of a mountainous relief due to uplift of the territory and subsequent division of the mountain range, especially due to the activities of consequent flows, is accompanied by the formation of a large quantity of molasses in the foreland of the forming mountain range. Sedimentation during the Middle Cretaceous Paleoalpine collision, is in the Western Carpathian space characterized predominantly by flysch, molasses are scarce. At the same time, there are early molasses, indicating extremely low sedimentation rate – 0.14 cm/100 years (Vass & Čech 1983). These are the lowest values of molasse sedimentation in the Western Carpathians, which is obvious from a comparison of the sedimentation rate of early molasse with molasses of the orogenic stage. These facts indicate rather that a mountain range did not form during the Paleoalpine period in the Western Carpathian space.

Relics of morphological forms and sediments belonging to Paleoalpine karst can be found practically in all Slovak mountains in which Middle/Upper Triassic limestones and dolomites of Hronic and Silicic occur. A gradual change of the primary structural relief on extensive carbonate rock complexes into a karst relief can be assumed in a broad coastal plain after the sea retreat in Middle Cretaceous.

The most widerspread surficial forms, formed during the Paleoalpine period, existing in the present relief are paleokarst plateaux (Slovak Karst, Muránska Planina, Slovenský Raj, Galmus, partly Strážovské vrchy and Malé Karpaty (Činčura 1993). Their surface has the character of an undulating plain or hillyland. A wide range of karst forms occurs on the surface of these paleokarst plateaux, from which part belong to the Paleoalpine period.

Shallow, only several meters deep and wide doline–like depressions (Malé Karpaty Mts., Strážovské vrchy Mts.) and deeper depressions most probably of canyon–like shape (Slovak Karst, Malé Karpaty Mts., Strážovské vrchy Mts.) are a common feature of the paleokarst. The fill of the shallow karst depressions (Valchov conglomerates) and deeper canyon–like depressions (red silty clays, boehmite–kaolinite bauxite and Valchov conglomerates) indicates the pre–Upper Cretaceous age of both types of karst depressions in Hronicum (Činčura 2000). Cave collapse breccias of Upper Cretaceous age which appear unconformably overlying Triassic limestones and dolomites are also a product of Paleoalpine karstification (Činčura 1992). The rauhwacke horizon which occurs at the soles of the cover nappe systems of Hronicum and Silicicum is considered as a vast hydrothermal karst system of Paleoalpine age (Činčura & Milovský 2000). Many examples from the Slovak Karst (laterite crusts of Upper Cretaceous age; Mello–Snopková 1973, turbidites; Marschalko & Mello 1993, in situ fresh water chalks of Upper Cretaceous age as filling of a doline; Cílek & Bednářová 1994, Cílek & Svobodová 1999)

5. Conclusions

There is evident, that very ancient karst forms which originated in the Paleoalpine karst period are an integral part of the contemporary ladscape of Western Carpathians. The decomposition sphere of a pre–Upper Cretaceous/Tertiary landscape and weathering products of this period are present on the present–day surface and near surface parts. These forms were created in climatic and tectonic environments that diametrically differ not only from the present–day circumstances but also from the Neoalpine (Miocene–Quaternary) ones. These forms have been mainly burried for sixty or seventy Ma, during the Upper Cretaceous, Paleogene and a part of Miocene and then exhumed.

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